Claims

1. A self-oxidation internal heating steam reforming system being structured to conduct self-oxidation of a raw material gas under the presence of oxygen and conduct steam reforming to generate a hydrogen-rich reformed gas, the self-oxidation internal heating steam reforming system comprising:

a steam generator 2 comprising a combustion section 2a to combust an air-fuel mixture obtained by mixing a combustion air with a fuel, thereby heating water by a combustion gas generated in the combustion section 2a to generate steam;

a first sucking mixer 4 for sucking the raw material gas into a steam stream coming from the steam generator 2 to obtain a raw material-steam mixture; and

a reformer 1 for oxidizing the raw material gas contained in the raw material-steam mixture by an oxygen-containing gas supplied externally, thereby conducting steam reforming of the raw material gas using a reaction heat of the oxidation to generate a hydrogen-rich reformed gas.

2. The self-oxidation internal heating steam reforming system as in claim 1, wherein a second sucking mixer 6 for sucking the fuel into the combustion air is disposed in order to obtain the air-fuel mixture.

3. The self-oxidation internal heating steam

reforming system as in claim 1, wherein a CO reducer 3 for oxidizing and reducing carbon monoxide contained in the reformed gas generated in the reformer 1 is disposed.

4. The self-oxidation internal heating steam reforming system as in claim 1, comprising a heat exchanger 13 for preheating or heating at least one of the fuel, the raw material gas, and other heating medium using a combustion flue gas discharged from the combustion section 2a.

5. The self-oxidation internal heating steam reforming system as in claim 1, wherein at least one of heat exchangers (12, 12a, 15, 16, and 17) for preheating at least one of the combustion air, the fuel, water for generating steam, the oxygen-containing gas for oxidization, and the raw material-steam mixture using the reformed gas discharged from the reformer 1 is disposed.

6. The self-oxidation internal heating steam reforming system as in claim 5, wherein at least one of the heat exchangers (12, 12a, 15, 16, and 17) is located to a reformed gas conduit at the downstream side of the CO reducer 3.

7. The self-oxidation internal heating steam reforming system as in claim 1, wherein the system is constructed such that, when a surplus occurs for the steam generated from the steam generator 2, at least a part of the surplus steam is used to heat other heating medium.

8. The self-oxidation internal heating steam reforming system as in claim 7, wherein the system is constructed such that the heating medium is water held in a hot-water tank 27 in which a main hot-water chamber 27a and an auxiliary chamber 27b are vertically communicated with each other, and that the surplus steam is supplied to the water in the auxiliary chamber 27b.

9. The self-oxidation internal heating steam reforming system as in claim 1, wherein the system is constructed such that the reformed gas is supplied to a fuel cell 300.

10. The self-oxidation internal heating steam reforming system as in claim 9, wherein the system is constructed such that an anode flue gas coming from the fuel cell 300 is supplied as a fuel to the combustion section 2a.

11. The self-oxidation internal heating steam reforming system as in claim 10, wherein the system is constructed so as to comprise a mixing section 116b for mixing at least a part of the surplus steam to the anode flue gas of the fuel cell 300; a heat exchanger 19 for dewatering a mixture obtained in the mixing section 116b by cooling the mixture using other heating medium to condense moisture; and a heat exchanger 18 for reheating the dewatered mixture using the mixture entered the mixing section 116b; thereby supplying the mixture coming from the

heat exchanger 18 for reheating as a fuel for the combustion section 2a.

12. The self-oxidation internal heating steam reforming system as in claim 1, wherein:

the reformer 1 comprises a first reaction chamber 61a and a second reaction chamber 62a separated from each other by a heat-conductive partition wall 62b;

the first reaction chamber 61a is provided with a raw material feed section 68 for supplying the raw material-steam mixture at one end and a discharge section 68a at the other end respectively, while packing a steam reforming catalyst bed 71a therein; and

the second reaction chamber 62a is provided with a raw material feed section 69a and an oxygen-containing gas introduction section 63 communicating with the discharge section 68a of the first reaction chamber 61a at one end and a discharge section 69 at the other end respectively, where the inside of the second reaction chamber 62a is packed sequentially with a mixed catalyst bed 72a prepared by mixing a steam reforming catalyst with an oxidation catalyst at the raw material feed section 69a side, a heat-transfer particle bed 72b at the middle section, and a shift catalyst bed 72e at the discharge section 69 side.

13. The self-oxidation internal heating steam reforming system as in claim 12, wherein the first reaction chamber 61a is packed with a heat-transfer particle bed 71b

at the raw material feed section 68 side, a steam reforming catalyst bed 71a at the discharge section 68a side, while making the heat transfer particle bed 71b in the first reaction chamber 61a, the heat transfer particle bed 72b in the second reaction chamber 62a, and the shift catalyst bed 72e face with each other via the respective partition walls 62b.

14. The self-oxidation internal heating steam reforming system as in claim 12, wherein the plurality of partition walls 62b have fixed ends joining with each other at respective edge sections at the raw material feed section 68 and the discharge section 69, while having free ends not having been joined with each other at the opposite end sections.

15. The self-oxidation internal heating steam reforming system as in claim 12, wherein the reformer 1, the steam generator 2, and the first sucking mixer 4 are integrated to form a package structure.

16. The self-oxidation internal heating steam reforming system as in claim 15, wherein the package structure further comprises a heat exchanger 12 for preheating the oxygen-containing gas for oxidation being supplied to the reformer 1 and/or preheating the combustion air being supplied to the steam generator 2.

17. A self-oxidation internal heating steam reforming system constructed to conduct self-oxidation of

a raw material gas under the presence of oxygen and conduct steam reforming to generate a hydrogen-rich reformed gas, the self-oxidation internal heating steam reforming system comprising:

a mixer 123 for mixing a raw material gas with a steam generated from a steam generator 2 to give a raw material-steam mixture; and

a reformer 1 for oxidizing the raw material gas in the raw material-steam mixture by an oxygen-containing gas supplied from outside, thereby conducting steam reforming of the raw material gas using a reaction heat of the oxidation to generate a hydrogen-rich reformed gas; wherein

the reformed gas is supplied to a fuel cell 300; and

a recycler 122 is disposed for supplying at least a part of an anode flue gas discharged from the fuel cell 300 as the raw material gas.

18. The self-oxidation internal heating steam reforming system as in claim 17, wherein the mixer 123 is constructed by a first sucking mixer 4 for sucking the raw material gas into a steam stream to obtain a raw material-steam mixture, and the first sucking mixer 4 sucks the anode flue gas.

19. The self-oxidation internal heating steam reforming system as in claim 17, wherein the steam generator 2 is constructed to comprise a combustion section 2a for combusting an air-fuel mixture obtained by mixing a

combustion air with a fuel, and to supply at least a part of the anode flue gas as the fuel.

20. The self-oxidation internal heating steam reforming system as in claim 19, wherein a second sucking mixer 6 is disposed for sucking the fuel into the combustion air to obtain the air-fuel mixture.

21. The self-oxidation internal heating steam reforming system as in claim 19, wherein a controller 14 is disposed for conducting control, when a surplus occurs for steam generated from the steam generator 2, of decreasing the supply quantity of the anode flue gas to the combustion section 2a to decrease the surplus steam, and of increasing the supply quantity of the anode flue gas to the mixer 123.

22. The self-oxidation internal heating steam reforming system as in claim 21, wherein a pressure detector 41 is disposed for detecting the pressure of steam generated from the steam generator 2 to inputs, when the detected pressure exceeds a predetermined value, the increased value to the controller 14 as the surplus quantity of steam, and the controller 14 performs control to decrease the supply quantity of the anode flue gas to the combustion section 2a so that the detected pressure becomes the predetermined value, and to increase the supply quantity of the anode flue gas to the mixer 123.

23. A self-oxidation internal heating steam

reforming system being structured to conduct self-oxidation of a raw material gas under the presence of oxygen and conduct steam reforming to generate a hydrogen-rich reformed gas, the self-oxidation internal heating steam reforming system comprising:

a mixer 123 for mixing a raw material gas with a steam generated from a steam generator 2 to give a raw material-steam mixture; and

a reformer 1 for oxidizing the raw material gas contained in the raw material-steam mixture by an oxygen-containing gas supplied from outside, thereby conducting steam reforming of the raw material gas using a reaction heat of the oxidation to generate a hydrogen-rich reformed gas; wherein

the reformed gas is supplied to a fuel cell 300, an anode flue gas discharged from the fuel cell 300 is supplied as the fuel of the steam generator 2 and/or the raw material gas;

the reformer 1 comprises at least a mixed catalyst bed 72a containing a mixture of a steam reforming catalyst and an oxidation catalyst, and a shift catalyst bed 72e; and

the shift catalyst bed 72e is provided with a heat exchanger 121 therein for preheating the anode flue gas discharged from the fuel cell 300.

24. The self-oxidation internal heating steam

reforming system as in claim 23, wherein the system is constructed such that;

the reformer 1 comprises a first reaction chamber 61a and a second reaction chamber 62a separated from each other by a heat-conductive partition wall 62b;

the first reaction chamber 61a is provided with a raw material feed section 68 for supplying the raw material-steam mixture at one end and a discharge section 68a on the other end respectively, while packing a steam reforming catalyst bed 71a therein; and

the second reaction chamber 62a is provided with a raw material feed section 69a and an oxygen-containing gas introduction section 63 communicating the discharge section 68a of the first reaction chamber 61a at one end, and a discharge section 69 at the other end respectively, where the inside of the second reaction chamber 62a is packed sequentially with a mixed catalyst bed 72a prepared by mixing a steam reforming catalyst with an oxidation catalyst at the raw material feed section 69a side, a heat-transfer particle bed 72b at the middle section, and a shift catalyst bed 72e at the discharge section side.

25. The self-oxidation internal heating steam reforming system as in claim 23, wherein a heat exchanger 19 is disposed for dewatering to remove moisture of the anode flue gas supplied to the heat exchanger 121.